Treatment of Fractures with Delayed Union

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TREATMENT OF FRACTURES WITH DELAYED UNION.

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CORRECT callus formation and bony union depend upon the co-operation of several factors: stimulation, nutrition, nervous influences, vital energy, etc.

The stimulation is produced by the original trauma, the extravasated blood, the contact of the fragments, and in later stages by the function of the limb. The stimulating action of the trauma does not need any explanation. Extravasated blood acts as a stimulant.

"In every case in which there is a fresh extravasation of blood, one sees the signs and symptoms of a slight inflammation. The affected part is painful, edematous and many times the patient has fever and feeling of heat in the part, at times also the patient has albuminuria.

"These phenomena, which are but the manifestations of the reaction of the body to the extravasation of blood, seldom fail, and are especially marked when, instead of the patient's own blood, that of another person is injected. The most intense reaction is called forth by the injection of the blood of animals." (Schmieden.)[1] Among the various components of the blood, the fibrin is to be

[1] V. Schmieden: Jour. Am. Med. Asso., 1907, 49, p. 395.

considered to play an especially important rôle in this line. Bergel [2] found proliferation of connective tissue after injecting fibrin in the subcutaneous tissue and in the peritoneum of dogs, in the latter place only when a slight lesion of the peritoneum was produced previously. He calls the fibrin an important and powerful protective and curative agent within the body, and states that it causes leucotaxis and hyperemia, that it favors the proliferation of granulation and connective tissue and stops the growth of bacteria.

In compound fractures, whether caused by accident or artificially produced, sometimes considerable delay of bony union results. This fact is explained by the loss of hematoma occurring often in such cases. Koenig,[3] therefore, who recommends the reduction of fragments by open incision, advises against washing out the blood clots in so far as they do not interfere with the contact of the fragments. Esmarch's constriction has in bone operation the special advantage that, after loosening the rubber bandage, considerable hemorrhage takes place within the tissues.

The contact of the fragments is not absolutely necessary for the union, as we can see especially in the fractures of the thigh, where, in spite of great deformity, the bones may be united by a large bridge of callus. Such cases are exceptional, however. Generally the contact of the fragments favors the callus formation. Insufficient contact, as for instance the over-riding displacement, or as occasionally seen in spiral fractures of long bones, is often followed by pseudarthrosis.

On the other hand, in cases where contact is present, the pressure of the fragments produced by the contraction of the muscles may be so great as to interfere with the nutrition.

[2] Bergel: Deut. Med. Wochenschrift, April, 1909.
[3] Koenig: Langenbeck's Archiv für Klinische Chirugie, vol. lxxvi.

Bardenheuer [4] calls special attention to this fact. He has among 10,000 simple fractures never seen any pseudarthrosis, except in fractures of the femoral neck, and claims as a reason for this result, the regulation of the pressure of the fragments by his extension method.

In the fixation method the function of the limb is not made use of to stimulate callus formation. More modern treatment, however, as the extension method and the treatment by massage and early motion, as inaugurated by Lucas Championnière,[5] make reasonable use of the function of the broken limb, not only in order to restore the function, but also to hasten bony union.

As a rule, the nutrition in fractures is well provided for with a few exceptions, as for instance in the fracture of the femoral neck. Furthermore, the circulatory disturbances usually accompanying fractures are supposed to have a beneficial influence upon the nutrition. The extravasated blood is not only a stimulating agent, but furnishes also nutritious material for the callus formation.

A few words need be said about the importance of vital energy and nervous influences upon the union of fractures. Lack of vital energy is the chief cause of delay of bony union or pseudarthrosis in cases of cachexia, senile marasmus, diabetes, chronic alcoholism, etc. In some nervous diseases, such as tabes and syringomyelia, pseudarthrosis or delayed union is often seen. Moreover, experiments of Biagi [6] have shown that cutting of the sciatic nerve results in pseudarthrosis in fractures of the tibia of rabbits.

In the treatment of fractures we have to keep

[4] Bardenheuer und Graessner: Die Technik der Extensionsverbände. Stuttgart, 1909, iv edition.

[5] Lucas Championnière: XIII international med. congress, Paris, 1900. Rev. Centralbl. für Chir., 1900, p. 1302.

[6] M. Biagi: Policlinico, 1905, p. 8. Rev. Centralbl. für Chir., 1907, p. 1243.

in mind these various points in order to avoid delayed union. It is not our intention, however, to discuss these interesting matters here in detail, but only so far as they are important for our special subject. We may pass over such indications as are found in the fractures of patients suffering from diabetes or syphilis, nor is it necessary to speak about the importance of general tonic treatment in anemic and marantic persons. Let us here only briefly consider the methods applied to delayed bony union in the fractures of otherwise healthy individuals with special reference to the mechanical stimulation.

The operative method is chiefly indicated when the retardation is due to the interposition or displacement of fragments. However, in such cases simple replacement and suture of the parts is often not sufficient. In three of our cases fixation was not obtained two to three months after the operation. It may be therefore advisable to apply greater stimulation by nailing the fragments or by implantation of foreign bodies like ivory pegs or pieces of bone with their periosteum. Strict asepsis is necessary in such cases, as any infection may interfere with the callus formation. I wish to report two cases of pseudarthrosis of the humerus which were operated upon a considerable time after the fractures. The fragments were freshened and sutured with silver wire. Slight infection took place, and little pus was discharged from a sinus. The fragments remained movable for several months. Finally by a new incision the wires were removed and bony union was then obtained in a remarkably short time. The explanation in such cases is not quite certain. It is possible that the tryptic ferments, contained in the leucocytes of the pus, interfere with the regenerative processes going on in the formation of callus.

The non-operative methods try to increase the stimulation and nutrition of the tissues the normal metabolism of which is disturbed. The methods applied for the accomplishment of this are mechanical, chemical, thermic, electric and biological stimulation, passive hyperemia, the introduction of thyroid extract into the general circulation, etc.

Stimulation is applied externally by the use of tincture of iodine or by the vesication of the skin; even eschars have been produced on the surface of the skin by caustic potassium and the red-hot iron. Electric current and electro-puncture have been applied with success in some cases. Injections of alcohol, oil of turpentine, tincture of iodine, zinc chloride or lactic acid to the point of fracture have also been made.

Bier [7] at first recommended the injection of blood, freshly drawn from the vein of the patient. There have been published a number of cases of delayed union and even of pseudarthrosis of long standing which have been healed in a remarkably short time by this method. Bier's passive or obstructive hyperemia has been used for hastening the bony union. Recently, Bum [8] and Hilgenreiner [9] have studied this question. The latter author recommends different forms of passive hyperemia in the different stages of the repair. In cases of slow or delayed union he recommends an obstruction of long duration, twelve or more hours daily, which will result in a slight edematous swelling. It seems doubtful to us whether such method is advisable in cases which often have edema and poor circulation, as did most of our cases. We used Bier's congestion in some cases,

[7] Bier: Medizinische Klinik, 1905, 1, 2.
[8] Bum: Centralblatt für Chirurgie, 1901, p. 1153.
[9] Hilgenreiner: Brun's Beiträge zur Klinischen Chirurgie, vol. liv, p. 531.

but only for one hour daily and in connection with mechanical stimulation. Whether it has had any additional effect has not been proven in our experience.

Non-operative mechanical stimulations have been used in different forms. Rubbing of the fragments against each other, striking with a small hammer and some kinds of massage have yielded good results. Walking with the injured leg in a plaster of Paris cast produces mechanical stimulation in cases of fracture of the lower extremity.

The method used in our cases consists in a firm, slightly-vibratory pressure with the fingers on the point of fracture. The aim is to stimulate the callus with as little movement of the fragments as possible. Rubbing the ends of the bones once together to produce laceration and hemorrhage within the callus is quite different from making frequent unnecessary manipulations, which tear the newly-formed tissue of delicate capillaries and bony spicules, thus preventing bony union.

Therefore we have constructed special plaster casts, from which the limb can be removed without shaking or pulling the fragments. For the same reasons we have strictly avoided all unnecessary trials to flex the fragments and have not examined the limb until we felt certain that considerable progress had been made.

X-ray plates were taken in the beginning of the treatment and later on every two or three weeks. In every case there was no distinct change to be seen in the first control-picture, but in the second, four to five weeks after the beginning of the treatment, such change was evident. The shadow of the calcified part of the callus was more dense than in the first picture, and there was calcification on places where there had

previously been none. In later stages, increase of the calcification was found in most pictures.

These changes in the x-ray pictures take place while clinically the callus becomes smaller, but firmer and more compact. It must be added, however, that the x-ray examination does not show, or at least only to a limited extent, the bony union which was evident in the clinical examination. This was especially true in Case III where we still found a distinct space between the fragments at the time when no elasticity was felt manually. This point has a special medico-legal interest. It is at times not possible from an old x-ray picture to state later on whether or not complete union was obtained clinically at the time the picture was taken. The changes seen in the x-ray pictures are quite distinct on the negative plates, but the prints do not show them plainly enough. We therefore have not made any reproductions, because they would not give the right idea of the real changes.

We have combined the mechanical stimulations with massage and passive movements in the joints in order to improve the function of the broken limbs which were in all cases completely useless. This combination is the great advantage of this method as compared with others which require fixation, as for instance, the operative methods. While moving the joints, care was taken not to shake the fragments themselves, and for this reason active movements were avoided the first time. The result of this combined treatment was that most of the patients were able to work in a short time after union of the fragments was obtained.

Case I. Nineteen-year-old healthy boy with simple fracture of both bones of the forearm. After fourteen weeks' treatment with fixation, the ulna was slightly,

the radius markedly flexible. The forearm was somewhat edematous, its muscles were very atrophic and wrist and fingers much limited in motion. Then he was treated with mechanical stimulation, massage and passive movements; in four weeks the bones were completely fixed, while the restoration of function needed further treatment for two months. X-ray pictures of this patient were not taken.

Case II. Twenty-seven-year-old healthy man came into the hospital Aug. 18, 1908, with a fresh compound fracture of both bones of the left forearm. Open cleaning of the wound and replacement of the bones were done immediately. In the first weeks there was much discharge from the wound, and the fragments of the radius slipped out of place again and freshening and suture were performed November 9 by a new operation. Jan. 2, 1909, the fragments of the radius showed still marked flexibility, while the ulna was only slightly elastic. The arm was completely useless and hardly any motion possible in the forearm, wrist and fingers. Then by daily stimulating treatment the fragments were united within seven to eight weeks, and in the same time wrist and fingers became readily movable; only supination and pronation were still much limited. Patient began to work in April, 1909. By the last examination in May there was found nearly perfect function of wrist and fingers and marked improvement of supination and pronation.

The first x-ray picture showed very little callus. On the control pictures four and seven weeks afterwards, the shadow of the callus became more dense and new bony structure was seen.

Case III. Fifteen-year-old healthy boy with compound fracture of the lower end of the radii of both arms. He was operated upon in the hospital a few hours after the accident, September, 1909. The right arm healed normally, while suppuration took place in the left. An abscess of the left wrist was opened November 27, and some sequestra removed. The edges of the fragments were curretted. On January 6, fourteen weeks after the fracture, the fragments of the left radius were still completely flexible, the hand and fin-

gers almost entirely useless. Stimulating treatment and massage was applied only ten times until March 25, when the bony union was perfect and the function very much improved.

The x-ray pictures showed in this case very little bony structure of the callus, and even at the time, when clinically the union was perfect, a distinct separation could be seen on the x-ray picture.

Case IV. Man of forty-eight years. Hard drinker. He sustained a compound fracture of both bones of the left forearm, the fragments were wired on the following day and the wound healed by granulation. January 6, fourteen weeks after the accident, both bones were markedly flexible, and the function of arm and hand was completely restricted. Stimulating treatment, massage and passive movements were applied daily. Within about eight weeks almost complete bony union was obtained, but then he loosened up the fragments again, probably by an accident when he had been drinking. The pictures showed slight but distinct growth of the bony callus.

Case V. A fifty-one-year-old healthy man with simple fracture of both bones of the forearm, November 16. Ten weeks later, on January 29, the bones showed no union, the fingers were almost completely stiff, also the wrist and forearm. By daily stimulating treatment, bony union was obtained within six to seven weeks, and at the end of April the patient was able to resume work with satisfactory function of his hand. The x-ray pictures showed marked increase of new-formed callus. The possition of the bone was improved to some extent as seen on the x-ray picture and clinically.

Case VI. Thirty-two-year-old healthy man, with compound comminutive fracture of the lower one third of the radius on Sept. 13, 1908. Slight infection took place in the second week, lasting for a short time. Jan. 28, 1909, the fragments were still very flexible, and the fingers much limited in flexion. Stimulating treatment was applied twenty-three times until March 12, when perfect union and satisfactory function were obtained. The x-ray pictures showed very little change of the callus.

Case VII. Thirty-seven-year-old man in good health. He sustained a simple fracture of the radius Aug. 30, 1908. He came to the hospital Jan. 21, 1909; then the fragments showed over-riding displacement, moderate callus, but no union. Therefore an operation was done; the periosteum was freed from the callus, a small piece excised, the deformity corrected by completing the fracture, holes were bored in the ends of the bone, and the fragments sutured with catgut. All bleeding points were carefully tied and the wound closed. On February 23 the fragments were slightly flexible. The active function of the hand was hindered by paresis of the musculus extensor communis and pollicis longus. Massage and functional treatment was given to the arm for three weeks, but at this time, whether by the treatment or by an accident we do not know, the fragments were loosened again and slipped partly out of place. Complete fixation for two and one half weeks did not make any improvement. Then stimulating treatment was daily applied while the patient was wearing a removable right-angle splint. Within four weeks the union was almost perfect and the function slightly improved.

The x-ray pictures showed distinct growth of the bony structures while the patient was under treatment.

Case VIII. Man forty-four years of age, in good health, with fracture of both bones of the right leg. Eleven weeks after the accident the fragments still showed slight elasticity of the callus. The leg was much swollen, the motion in the foot limited, and marked peroneal spasm was present. Complete union and satisfactory function was obtained within four to five weeks by stimulating and functional treatment.

Case IX. A thirty-four-year-old healthy man with fracture of the ground phalanx of the second finger of the left hand, on Dec. 10, 1908. The bones were reset on February 3 by an open incision. On March 27 there was still a slight elasticity of the fragments, and the finger was quite stiff. Stimulating treatment was applied, and after three weeks no elasticity was felt and the finger became more flexible.

In conclusion, I wish to emphasize the sim-

plicity and efficiency of the methods here described in treating a class of cases, often so obstinate under ordinary treatment. Moreover, greater routine use of functional and stimulating methods would be of great prophylactic value in those cases as well as of great advantage in all fractures.

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